INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

PHYSICS

Higher Level

Friday 14 May 1999 (afternoon)

Paper 1 — 1 hour

This examination paper consists of 40 questions.
Each question offers 4 suggested answers.
The maximum mark for this paper is 40.

INSTRUCTIONS TO CANDIDATES

Do NOT open this examination paper until instructed to do so.

Answer ALL questions.

For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

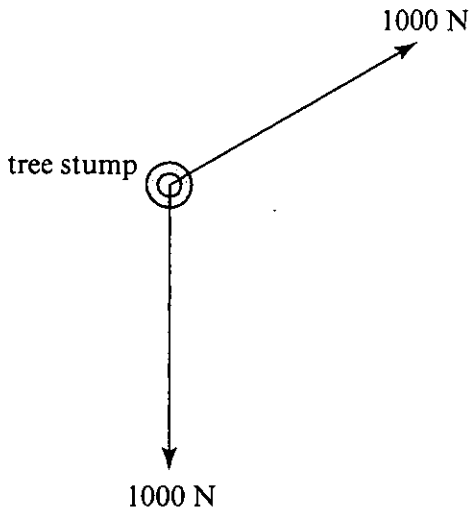
Calculators are NOT permitted for this examination paper.

EXAMINATION MATERIALS

Required:
Optically Mark Read (OMR) answer sheet
Physics HL Data Booklet

Allowed:
A simple translating dictionary for candidates not working in their own language

1. To pull a tree stump out of the ground, two tractors pull on ropes as shown in the diagram below. The view is from the top.



Which of the following is the best estimate for the magnitude of the **resultant** of these two forces?

A. 0 N

B. 1000 N

C. 1500 N

D. 2000 N

2. An object, initially at rest, is subjected to a constant resultant force. Readings are taken of its velocity v at different distances s from its starting position.

Which one of the following graphs should be plotted to yield a straight-line graph?

A. s versus v

B. s versus v^2

C. s^2 versus v

D. s^2 versus v^2

3. In order to determine the density of a certain type of wood, the following measurements were made on a **cube** of the wood.

Mass	= 493 g
Length of **each** side	= 9.3 cm

The percentage uncertainty in the measurement of mass is ±0.5% and the percentage uncertainty in the measurement of length is ±1.0%.

The best estimate for the uncertainty in the density is

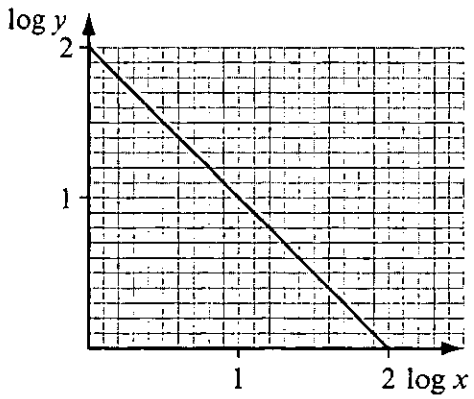
A. ±0.5%

B. ±1.5%

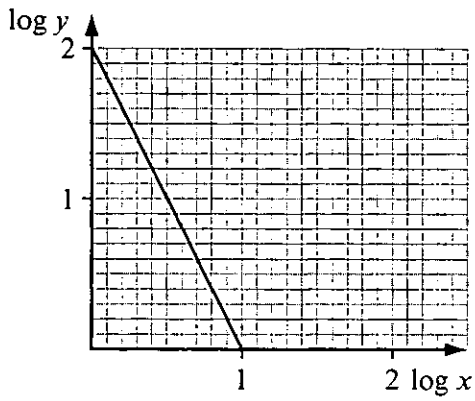
C. ±3.0%

D. ±3.5%

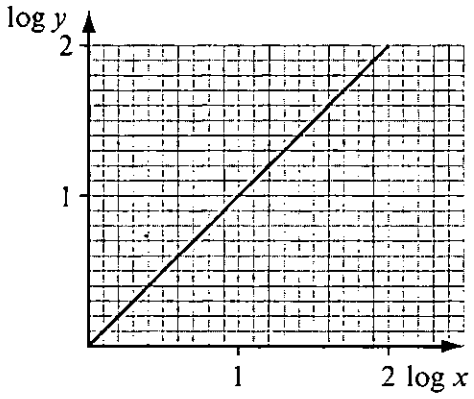
4. The graphs A to D below are plots of log y against log x in arbitrary units.



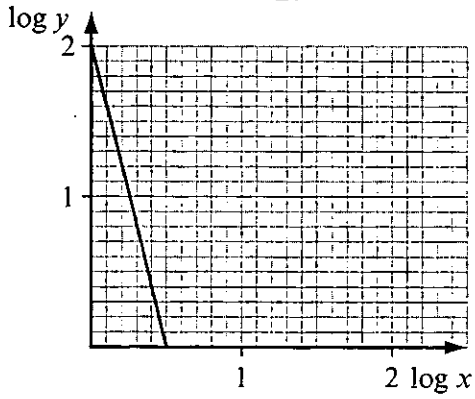
A.



B.



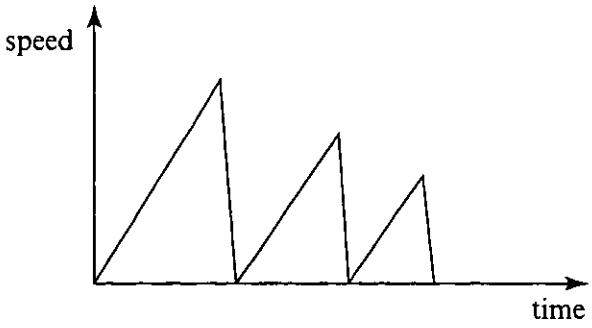
C.



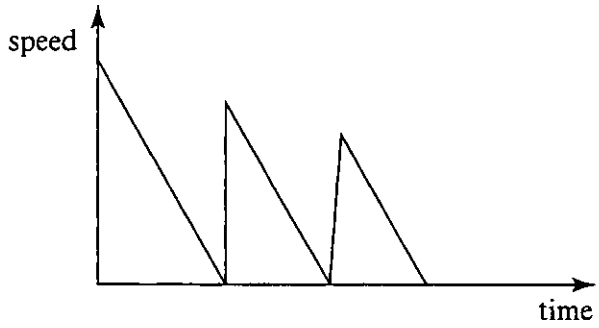
D.

Which one of the graphs best represents the variation of y, the electrostatic potential due to a positive point charge, with x, the distance from the point charge?

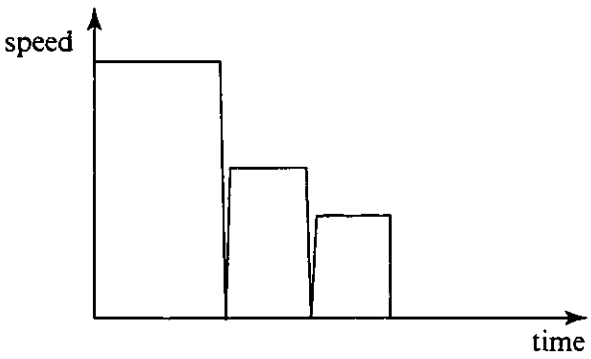
5. A tennis ball is dropped to the floor and bounces several times. Which one of the following graphs best shows its **speed** versus time?



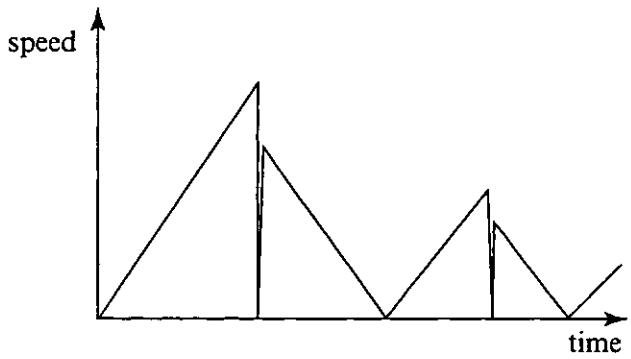
A.



B.

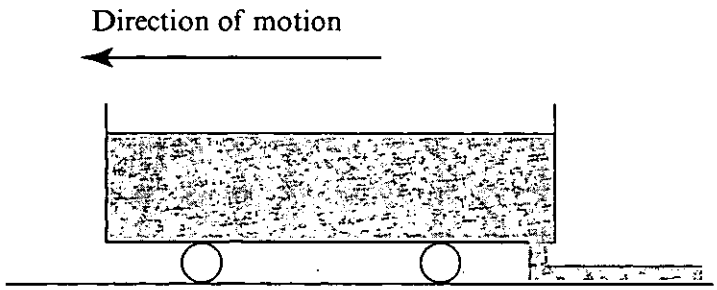


C.



D.

6. The diagram shows a train car that is loaded with fine sand.



It is coasting at a constant speed along a long horizontal rail where frictional effects are negligible. A hole develops in the bottom of the car and sand starts spilling out onto the ground below at a constant rate. While the sand is spilling out the speed of the train car will

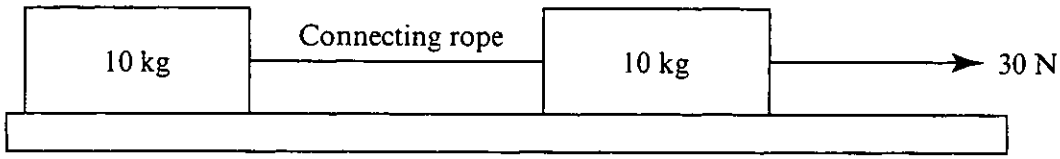
A. increase uniformly.

B. decrease uniformly.

C. increase non-uniformly.

D. remain constant.

7. Two 10 kg blocks on a smooth horizontal surface are tied together. They are accelerated by a horizontal force of 30 N which acts as shown below:



If frictional effects are negligible, what is the tension in the connecting rope?

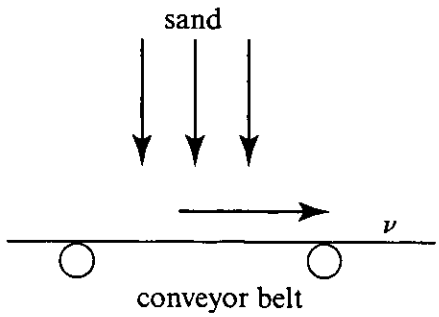
A. 30 N

B. 15 N

C. 10 N

D. 0 N

8. Sand is poured vertically on to a moving conveyor belt at a steady rate so that the mass of sand landing per unit time is μ. The conveyor belt maintains a constant speed of v. The sand slips on the conveyor belt until it also reaches the speed v.



The minimum power required to keep the conveyor belt moving at constant speed while the sand is falling on it will be

A. zero.

B. μv.

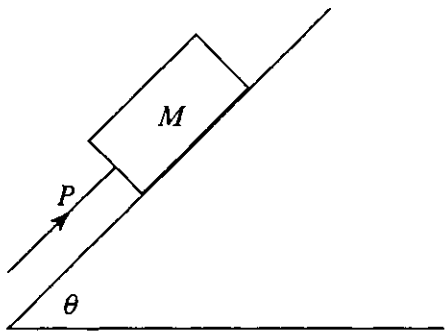
C. $\frac{1}{2} \mu v^2$.

D. μv^2.

9. Two freely moving objects collide and stick together. If they are still moving after the collision, which one of the following is correct?

	Total Kinetic Energy	**Total Momentum**
A.	remains unchanged	remains unchanged
B.	remains unchanged	decreases
C.	decreases	decreases
D.	decreases	remains unchanged

10. A force P directed up a plane, of angle θ to the horizontal, prevents a block of mass M from slipping down, as shown in the diagram.



If the coefficient of static friction between the block and the plane is μ, the **minimum** magnitude of force P required, is

A. $Mg \sin \theta$

B. $Mg (\sin \theta - \mu \cos \theta)$

C. $Mg (\sin \theta + \mu \cos \theta)$

D. $Mg (\cos \theta - \mu \sin \theta)$

11. Two different springs of equal unstretched lengths have spring constants k_1 and k_2. They hang vertically with masses m_1 and m_2 attached to them respectively. If the systems oscillate with equal periods, which one of the following is true?

A. $m_1 k_2 = m_2 k_1$

B. $m_1 k_1 = m_2 k_2$

C. $m_1 \sqrt{k_1} = m_2 \sqrt{k_2}$

D. $m_1 \sqrt{k_2} = m_2 \sqrt{k_1}$

12. A planet X has half the radius of a planet Y but the same density as planet Y.

The ratio $\frac{\text{acceleration of free fall at surface of planet X}}{\text{acceleration of free fall at surface of planet Y}}$ will be

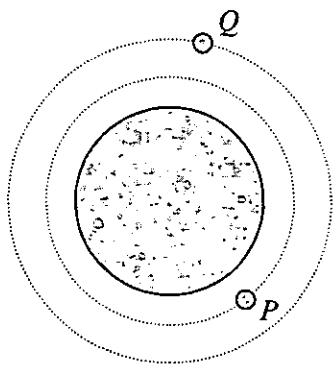
A. 2:1

B. 1:2

C. 1:4

D. 1:1

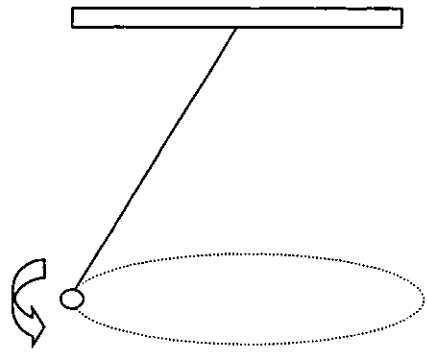
13. Two identical satellites, *P* and *Q*, are both in circular orbits about the same planet. The radius of orbit of satellite *P* is less than that of satellite *Q*.



Which one of the following comparisons is correct?

	Kinetic Energy of *P* compared to Kinetic Energy of *Q*	**Potential Energy of *P* compared to Potential Energy of *Q***
A.	Greater	Less
B.	Greater	Greater
C.	Less	Less
D.	Less	Greater

14. A mass on the end of a string is moving at a constant speed in a horizontal circle of constant radius as shown below.



At any point in the motion which one of the following quantities is **zero**?

A. Angular momentum

B. Linear acceleration

C. Linear momentum

D. Angular acceleration

15. A small block of metal is taken out of boiling water, where it had come to equilibrium at 100 °C, and placed into a calorimeter containing water at 0 °C. The mass of the block is equal to the mass of cold water. The specific heat capacity of the metal is less than that of the water. Ignoring any transfer of thermal energy to the container, the equilibrium temperature of the block plus water will be

A. less than 50 °C.

B. 50 °C.

C. more than 50 °C.

D. 100 °C.

16. A bimetallic strip is made of brass and iron as shown below. At room temperature, it is straight.

The coefficients of linear expansion for brass and iron are given below:

$$\alpha_{brass} = 2.4 \times 10^{-5}\ K^{-1}$$
$$\alpha_{iron} = 1.1 \times 10^{-5}\ K^{-1}$$

Which one of the following correctly states what will happen when the temperature of the strip is increased or decreased?

	Temperature of strip increased	**Temperature of strip decreased**
A.	Bends down	Bends up
B.	Bends down	Bends down
C.	Bends up	Bends up
D.	Bends up	Bends down

17. Three products are being considered as possible thermal insulators. The thicknesses and conductivities of the three products are as follows:

	Conductivity /arbitrary units	**Thickness /arbitrary units**
Product I	12	4
Product II	6	6
Product III	4	2

For a given cross-sectional area, which product would make the best thermal insulator?

A. Product I

B. Product II

C. Product III

D. They would all give the same insulation.

18. An ideal gas expands **isothermally**, absorbing a certain amount of energy, Q, in the process. It then returns to its original volume **adiabatically**. During the adiabatic process, the internal energy change of gas will be

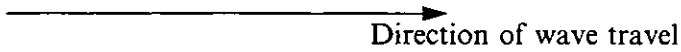
A. zero.

B. smaller than Q.

C. equal to Q.

D. greater than Q.

19. A transverse wave is travelling from left to right as shown below.



Given only the above information, one can deduce that the direction of the oscillations **must** be

A. up and down the paper.

B. left and right on the paper.

C. in and out of the paper.

D. at right angles to the direction of wave travel.

20. When light hits the interface between a certain type of glass and air, the critical angle is 42°. If the angle of incidence measured in the glass is equal to 45°, the light will be

A. totally internally reflected at 42°.

B. totally internally reflected at 45°.

C. refracted at less than 45°.

D. refracted at greater than 45°.

21. A sinusoidal transverse wave of amplitude, A, travelling in the positive x-direction, has a time period of T and a wavelength of λ.

The equation for this wave is

A. $y = A\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$

B. $y = A\sin 2\pi(Tt - \lambda x)$

C. $y = A\sin 2\pi\left(\frac{t}{T} + \frac{x}{\lambda}\right)$

D. $y = A\sin 2\pi\left(Tt + \frac{x}{\lambda}\right)$

22. Light from two sources can produce interference fringes on a screen provided that the two sources are coherent. The word **coherent** means that the two sources

A. have the same amplitude.

B. need to be closer together.

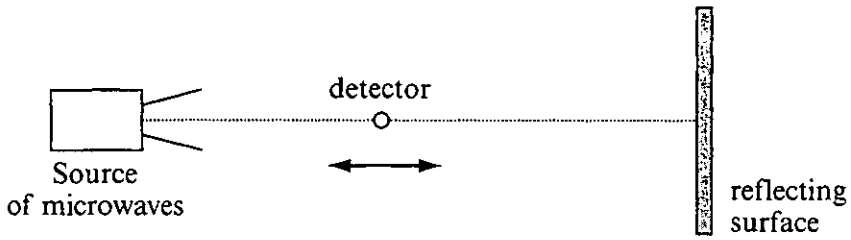
C. have a fixed phase relationship.

D. emit polarised light.

23. A train approaches, and passes through, a station. During this period the velocity of the train is constant and the engine is continuously sounding its whistle. Which one of the following correctly describes what an observer on the platform will hear?

	Sound heard as the train is **approaching** the station	Sound heard as the train is **passing through** the station
A.	Constant frequency	Increasing frequency
B.	Increasing frequency	Decreasing frequency
C.	Decreasing frequency	Increasing frequency
D.	Constant frequency	Decreasing frequency

24. Microwaves of wavelength 4.0 cm are emitted normally towards a reflecting surface and they are reflected back. A detector, which measures the net microwave intensity, moves along the line joining the emitter and reflector as shown below.



The distance moved by the detector between one point of minimum intensity and **the next** minimum point will be

A. 0.5 cm

B. 1.0 cm

C. 2.0 cm

D. 4.0 cm

25. A solid spherical conductor is electrically charged. Which one of the following combinations is true in respect of the electric potential and the electric field at all points **inside** the conductor.

	Potential	**Field**
A.	Zero	Constant but not zero
B.	Constant but not zero	Zero
C.	Zero	Zero
D.	Constant but not zero	Constant but not zero

26. A sample of wire is coiled to make a solenoid, of length, l, and diameter, D. When a given current flows in the wire, the magnetic field strength in the solenoid is B.

The coils of this solenoid are now unwound and the **same sample of wire** is used to produce a new solenoid of half the diameter, $D/2$, and twice the length, $2l$. If the new solenoid carries the same current as before, the field strength in the solenoid will be

A. $B/2$

B. B

C. $2B$

D. $4B$

27. An alternating voltage of **peak** value 300 V is applied across a 50 Ω resistor. The average power dissipated in watts will be

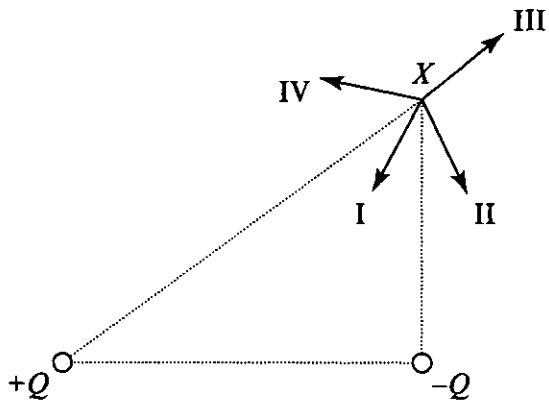
A. zero

B. $\frac{(300)^2}{50}$

C. $\frac{(300)^2}{50\sqrt{2}}$

D. $\frac{(300)^2}{50 \times 2}$

28. The diagram shows two charges of magnitude $+Q$ and $-Q$. Which of the labelled arrows best shows the direction of the electric field at the point X?



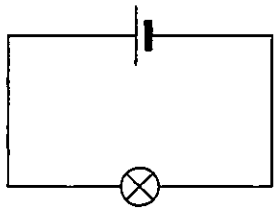
A. I

B. II

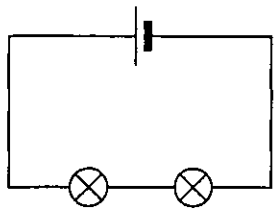
C. III

D. IV

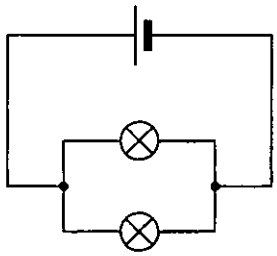
29. In an experiment, identical new batteries were connected to each of the following combinations of identical bulbs. In which situation would the battery lose all its stored energy in the **shortest** amount of time?



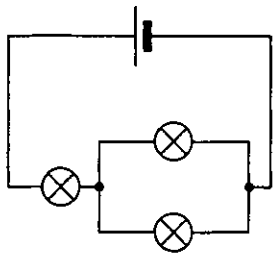
A.



B.

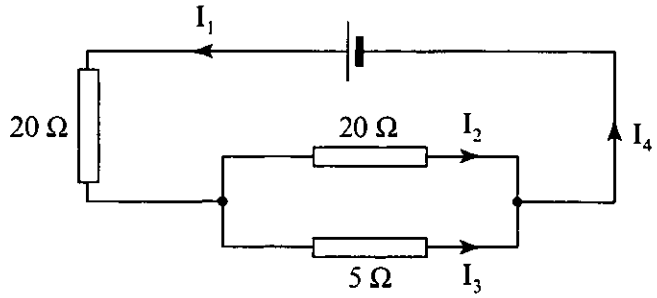


C.



D.

30. A circuit consists of a battery and three resistors as shown below. The currents at different parts of the circuit are labelled. Which of the following gives a correct relationship between currents?



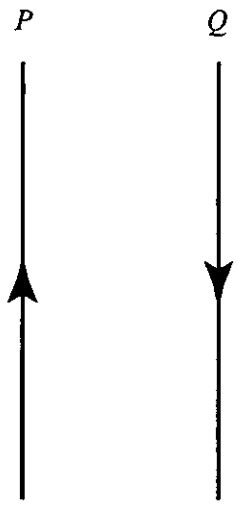
A. $I_2 = I_3$

B. $I_1 = I_2$

C. $4I_3 = I_2$

D. $4I_2 = I_3$

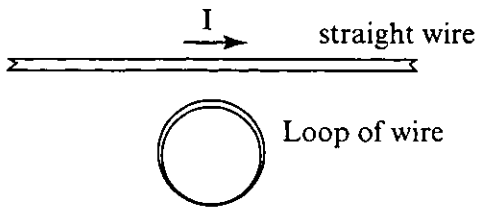
31. Currents flow in two wires P and Q as shown in the diagram.



Which combination gives the correct field direction at Q and the force on Q, due to the current in P?

	Direction of field at Q due to current in P	**Direction of force on Q due to current in P**
A.	into plane of paper	towards P
B.	out of plane of paper	towards P
C.	into plane of paper	away from P
D.	out of plane of paper	away from P

32. In the arrangement shown below, if the current in the straight wire is **increasing** with time, the current induced in the loop will be



A. zero.

B. clockwise.

C. anticlockwise.

D. alternating.

33. Oxygen-15 decays to nitrogen-15 with a half-life of approximately 2 minutes. A pure sample of oxygen-15, with a mass of 100 g, is placed in an airtight container. After 4 minutes, the masses of oxygen and nitrogen in the container will be

	Mass of oxygen	**Mass of nitrogen**
A.	0 g	100 g
B.	25 g	25 g
C.	50 g	50 g
D.	25 g	75 g

34. A radioactive nuclide ${}_{z}X$ undergoes a sequence of radioactive decays to form a new nuclide ${}_{z+2}Y$. The sequence of emitted radiations could be

A. β, β.

B. α, β, β.

C. α, α.

D. α, β, γ.

35. Given that ^{238}U has a half-life of 4.5×10^9 years, what is the probability that **a particular atom** of ^{238}U will have decayed after 9×10^9 years?

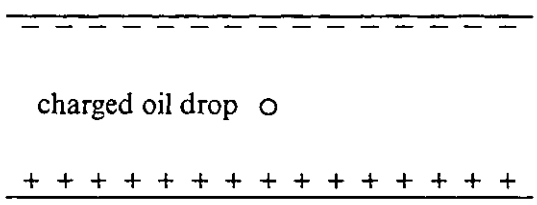
A. 0.25

B. 0.5

C. 0.75

D. 1.0

36. An oil drop of mass m and charge $+3e$ is at rest between two parallel horizontal electrically charged plates as shown below.



Ionising radiation causes the charge on the drop to change to $+2e$. The **resultant force** on the drop at this instant will be

A. $\frac{2}{3}mg$ downwards.

B. $\frac{1}{3}mg$ downwards.

C. $\frac{2}{3}mg$ upwards.

D. $\frac{1}{3}mg$ upwards.

37. A radioactive sample decays with a half-life of approximately 1 hour. The best estimate for the time taken for the activity of the sample to decrease to $\frac{1}{30}^{th}$ of its initial value is

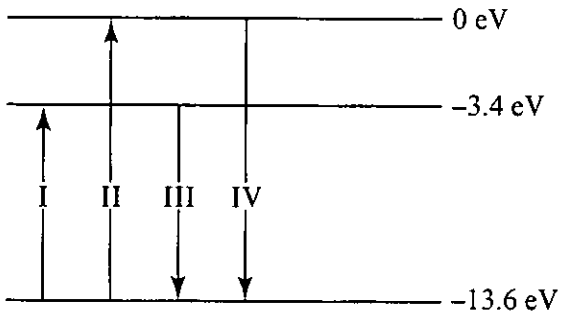
A. 3 hours.

B. 5 hours.

C. 15 hours.

D. 30 hours.

38. The diagram below shows possible transitions between three energy levels in the hydrogen atom. Which electron transition would be associated with the **emission** of a photon of the **shortest** wavelength?



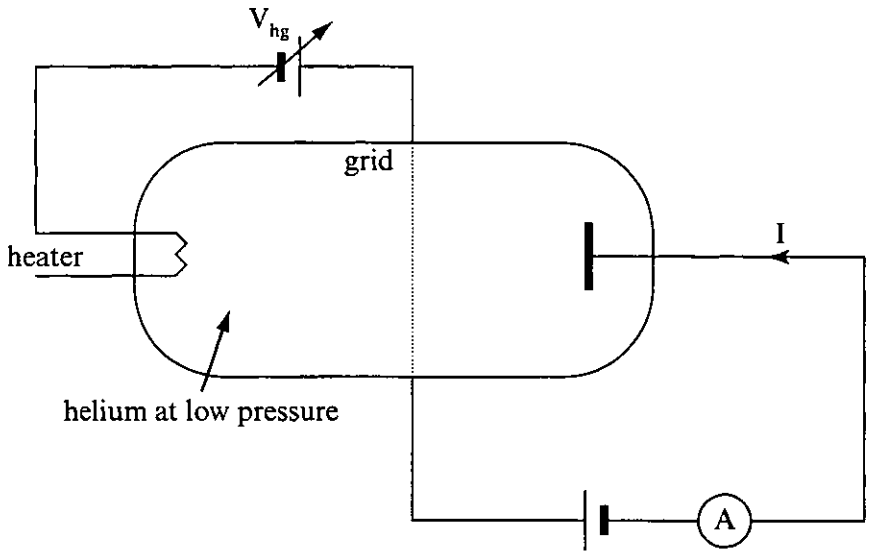
A. I

B. II

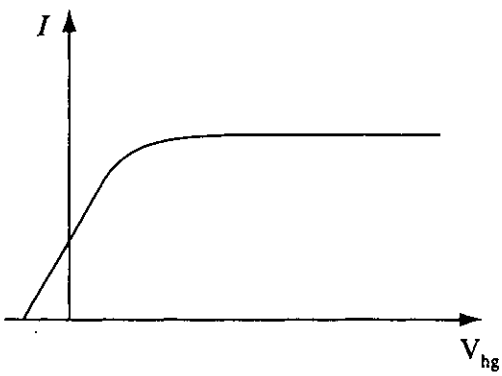
C. III

D. IV

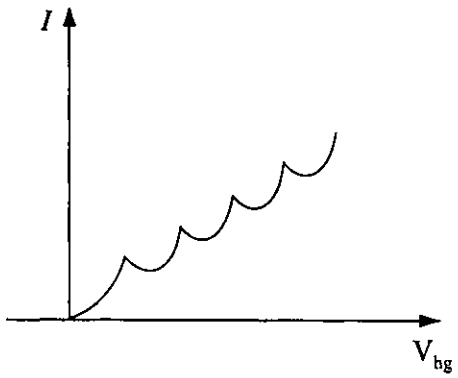
39. The diagram below is a sketch of the apparatus used in the Franck and Hertz experiment. Helium at low pressure is trapped in the container. The values of anode current, I, were recorded for different values of potential difference between heater and grid, V_{hg}.



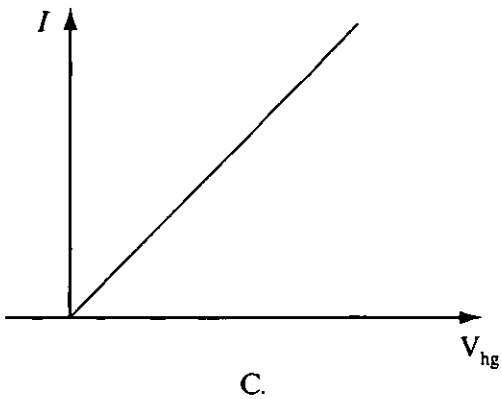
Which one of the following graphs best represents the results obtained?



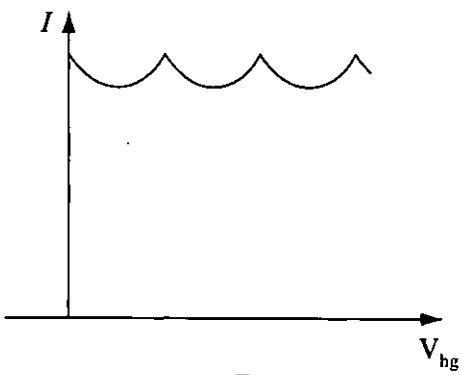
A.



B.



C.



D.

40. The kinetic energies of two electrons are in the ratio 4:1. Assuming any relativistic mass increase can be ignored, the respective de Broglie wavelengths of the electrons will be in the ratio

A. 2:1

B. 1:2

C. 4:1

D. 1:4